Measurement of the top quark mass in the lepton + jets channel at D0 using the Ideogram Method

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Event selection

<u>event selection</u>

- One isolated lepton
  with $p_T > 20$ GeV and
  $|\eta| < 2.0$ (muons) or 1.1 (electrons)

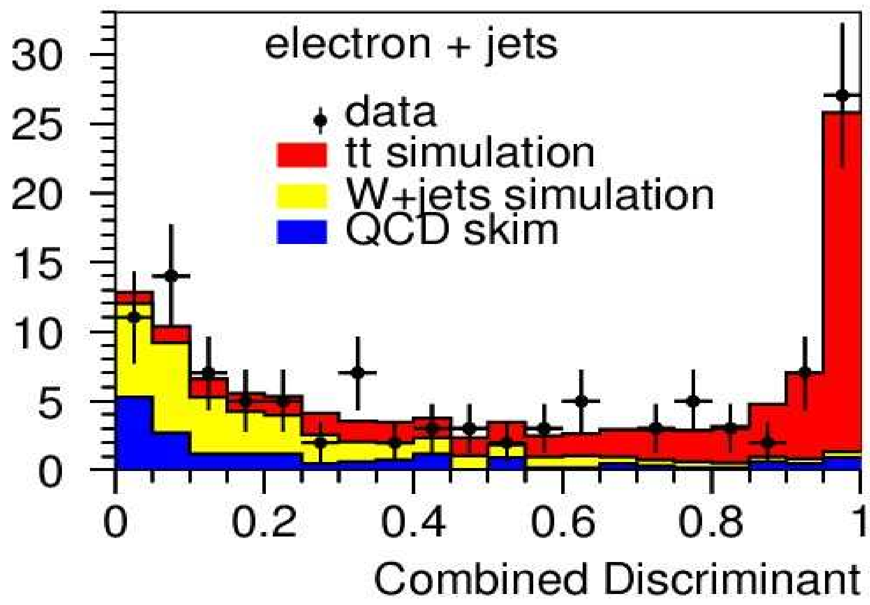
- $\not{E}_T > 20$ GeV

- ≥ 4 jets with $p_T > 20$ GeV
  and $|\eta| < 2.5$

- A $\Delta\phi$ cut between the $\not{E}_T$ and
  the charged lepton

	e+jets	μ+jets
tt	61.5 ± 7.9	45.6 ± 7.5
W+jets	35.6 ± 5.2	63.0 ± 6.9
QCD	18.9 ± 2.7	5.4 ± 0.6
total observed	116	114

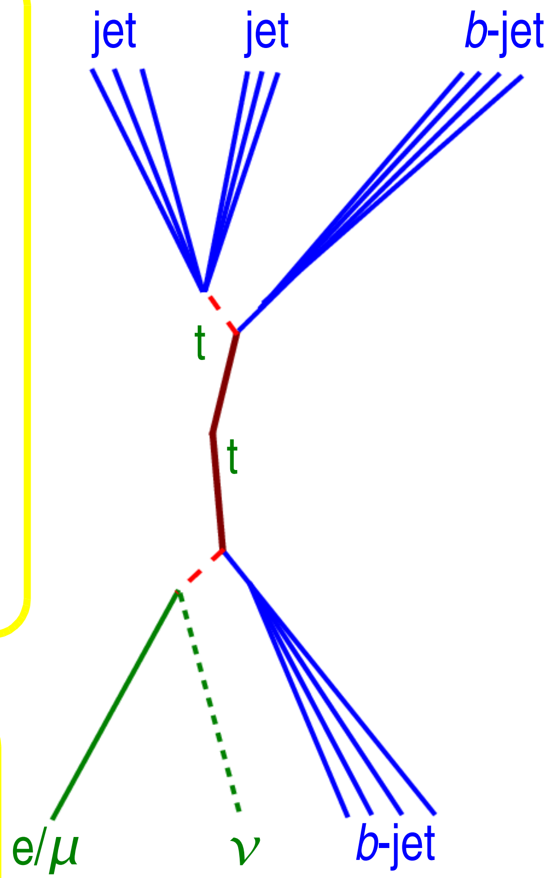
RunII sample with $L_{integrated} = 425\ pb^{-1}$



- Number of b tags
- aplanarity
- $\not{E}_T$
- $H'_{T2} = H_{T2} / H_{||}$
- $K'_{T\,min}$
- An event quality variable combining track
  and jet information

Kinematic fit

- measured variables:
  4 jet energies, 4 jet directions
  lepton energy, lepton direction
  $\not{E}_T$ and the direction of the $\not{E}_T$
- fit tt hypothesis to these kinematic variables
- Constraints: both W masses are constrained to the known W mass.
  Both top masses are required to be the same. This gives a
  2 constraints fit.
- per jet-parton assignment: m_t , σ_t a χ^2



· Previously: Largest systematic from uncertainty on jet energy scale.
Now: Take the jet energy scale from the hadronic W's in this sample.
· Divide all jet energies by an overall JES factor: JES.
· The kinematic fit is best (lowest χ^2) at JES at which the reconstructed W mass is closest to 80.4 GeV.

Ideogram Method

Compute an event likelihood of three variables: m_t, JES, and f_{top}:

$$\mathcal{L}_{\text{evt}}(m_t, JES, f_{\text{top}}) = f_{\text{top}} \cdot P_{\text{sgn}}(m_t, JES) + (1 - f_{\text{top}}) \cdot P_{\text{bkg}}(JES)$$

$$P_{\text{sgn}}(m_t, JES) = P_{\text{sgn}}(D) P_{\text{sgn}}(\text{fit}; m_t, JES)$$

(same for BG)

$$P_{\text{bkg}}(\text{fit}; JES) = \sum_{i=1}^{24} w_i \cdot \mathbf{BG}(m_i)$$

$$P_{\text{sgn}}(\text{fit}; m_t, JES) = \sum_{i=1}^{24} w_i \left\{ \int \mathbf{G}(m_i, m', \sigma_i) \cdot \mathbf{BW}(m', m_t) dm' + \mathbf{S}_{\text{wrong}}(m_i, m_t) \right\}$$

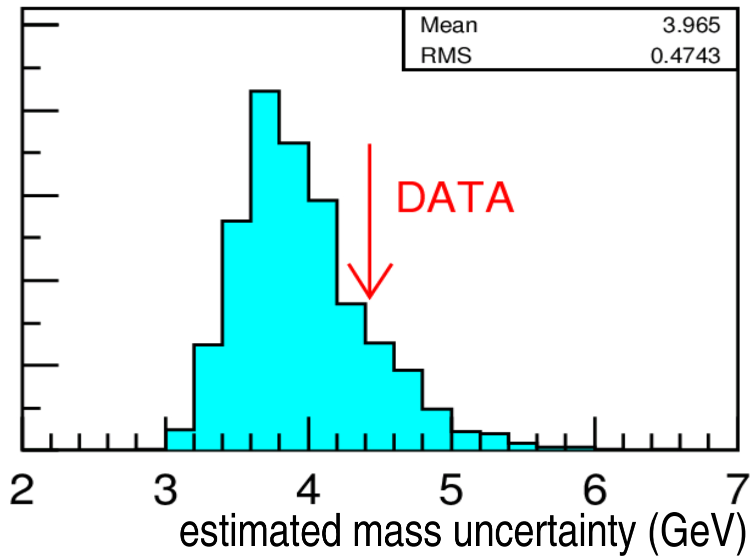
$$e^{-\frac{1}{2}\chi_i^2} \cdot \text{Prob}_{\text{b-tagging}}$$

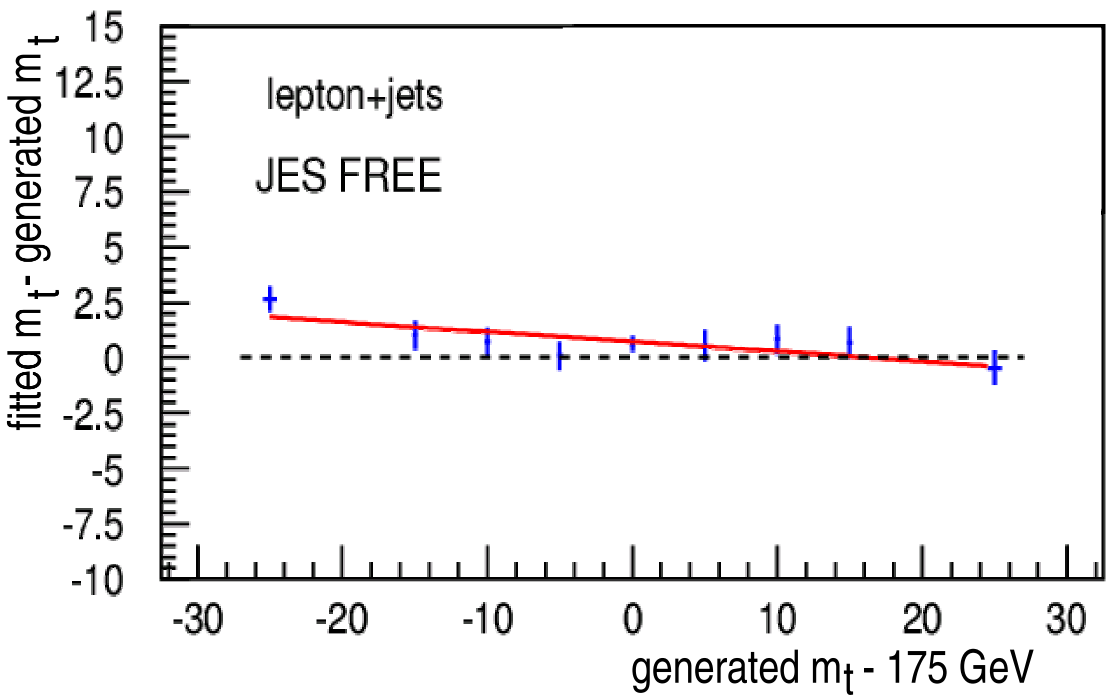
Total likelihood is the product of the event likelihoods

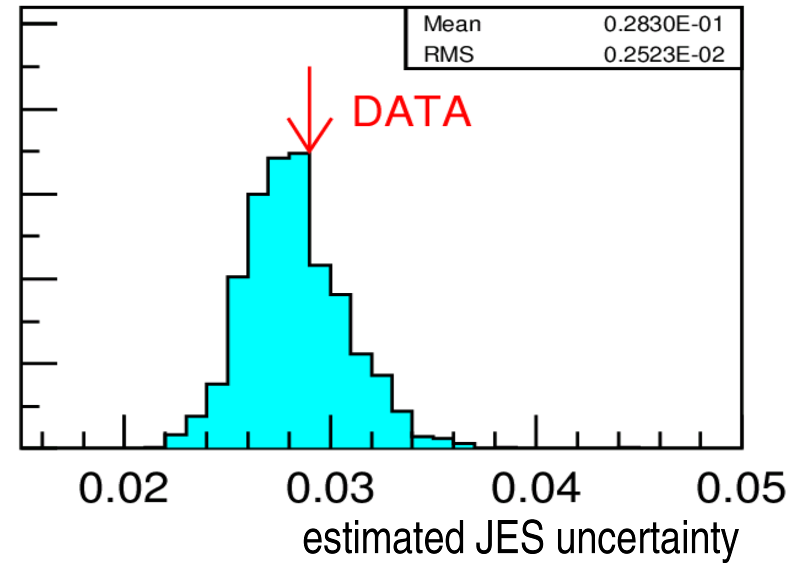
$$\mathcal{L}_{\text{samp}}(m_t, JES, f_{\text{top}}) = \prod_j \mathcal{L}_{\text{evt}_j}(m_t, JES, f_{\text{top}})$$

Ensemble tests

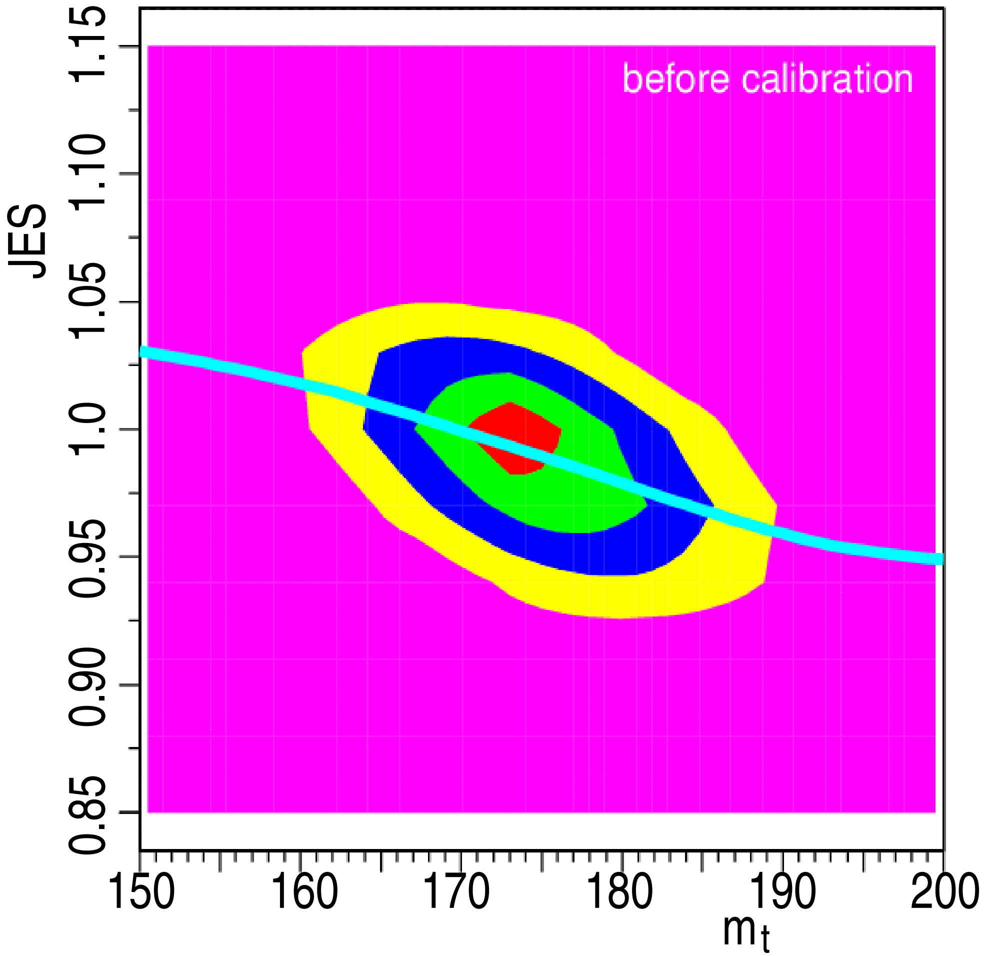
Pseudo-experiments to determine the estimated uncertainty, the calibration, and the pull width using Pythia tt MC and Alpgen W+jets MC.

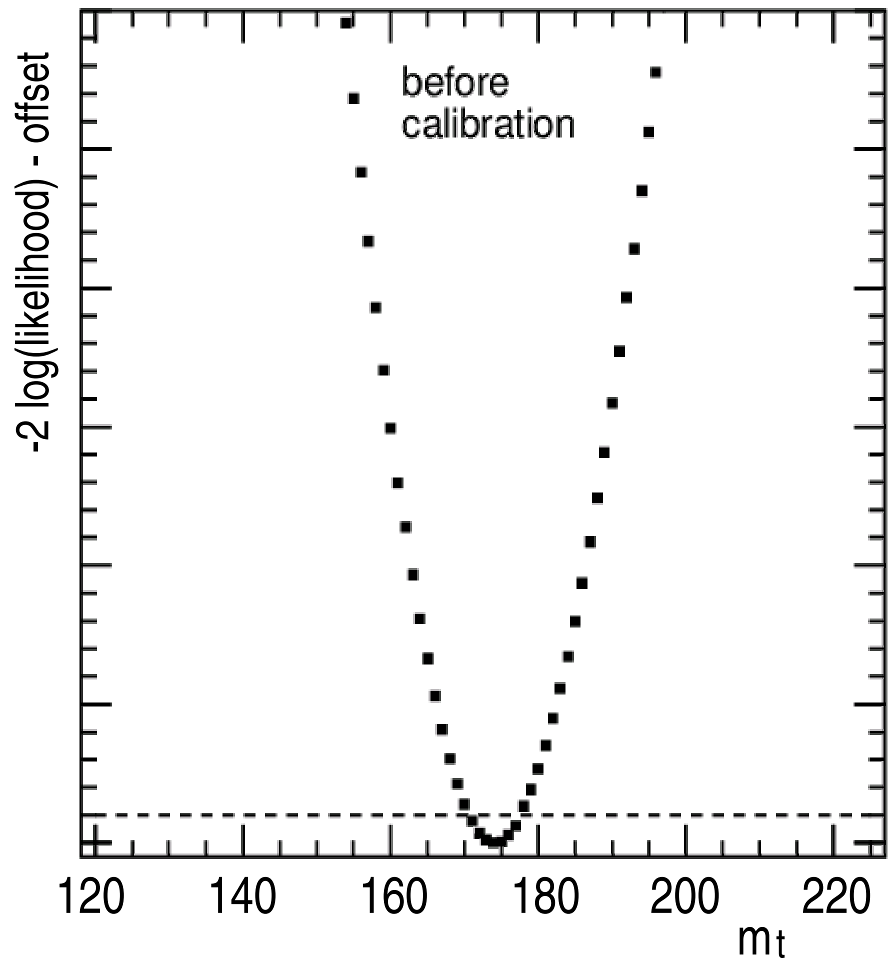






Result





m_t (l+jets) $= 173.7 \pm 4.4$ (stat)$^{+2.1}_{-2.0}$ (sys) GeV

JES = 0.989 ± 0.029 (stat. only)

Systematic uncertainties

The systematic uncertainties (in GeV):

jet energy scale (p_T dependence)	0.45
jet ID efficiency and resolution	0.22
b fragmentation	1.30
b response	1.15
b tagging	0.29
trigger uncertainty	+0.61 -0.28
signal modeling	0.73
signal fraction	0.12
background modeling	0.20
QCD background	0.28
MC calibration	0.25
PDF uncertainty	0.02

total systematic uncertainty = +2.10 -2.04 GeV

Conclusions

- The ideogram method is well capable of reconstructing a top mass from a data sample
- Inclusing b-tagging has greatly improved the method.
- Including a JES factor taken from the hadronic W boson, shifts a systematic uncertainty to the statistical uncertainty and significantly reduces the total uncertainty.
- The fitted JES factor is compatible with the external photon-jet jet energy scale.
- Applied on a 425 pb^{-1} dataset the ideogram method finds a top mass of

$$m_t = 173.7 \pm 4.4\,(\mathrm{stat})\,^{+2.1}_{-2.0}\,(\mathrm{sys})\ \mathrm{GeV}$$

- Analysis submitted to PRD.

- We are working on an updated analysis on a larger dataset.